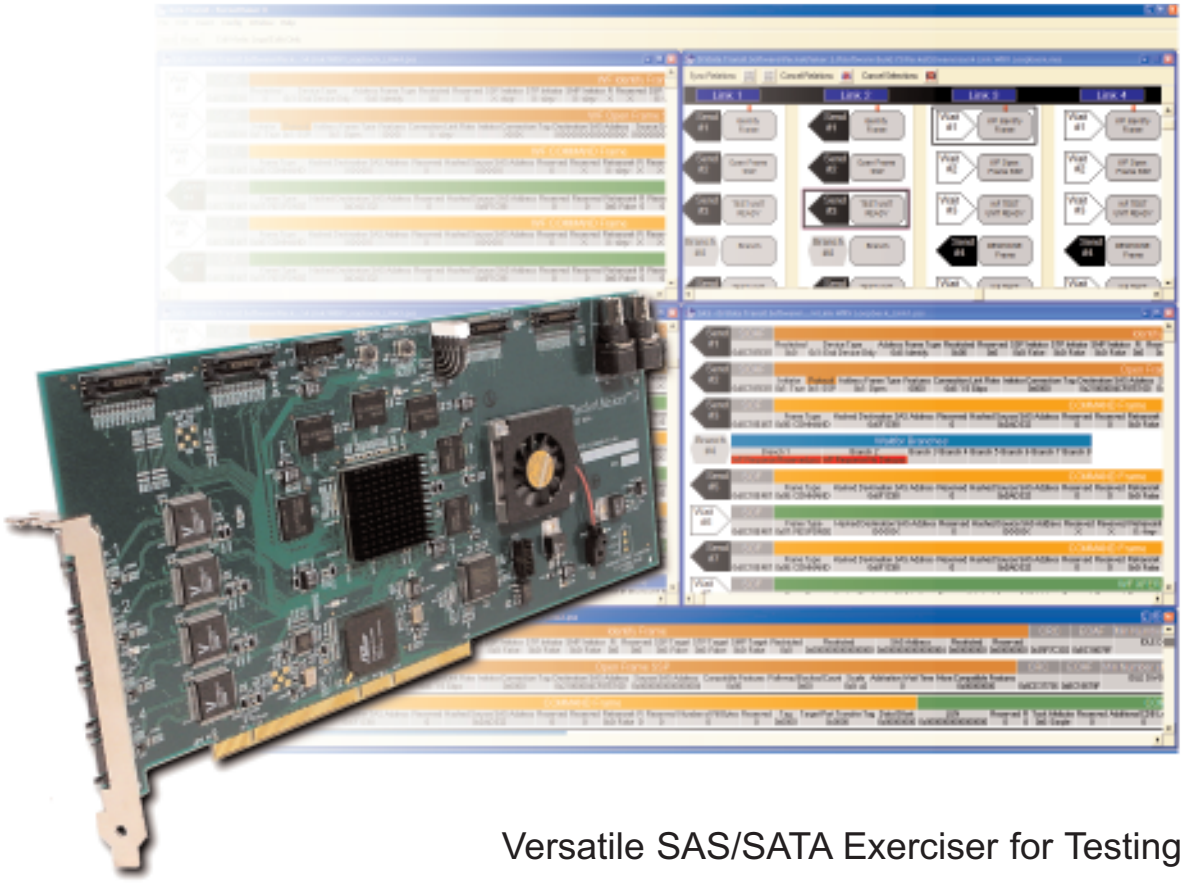
SAS PacketMaker™ II

Serial Attached SCSI (SAS), Serial ATA (SATA) Traffic Generator/Exerciser/Tester
Data Sheet



Versatile SAS/SATA Exerciser for Testing
1.5 & 3.0 Gb/s SAS Wide Ports and SATA

NETWORK TOOLS
Finisar Corporation

OVERVIEW

The Serial Attached SCSI (SAS) PacketMaker II (PM2) is a versatile SAS traffic generator capable of initiator and target emulation with an integrated SAS recorder. All SAS protocols are supported including SSP, STP and SMP. In addition, PM2 supports SATA. Users can work at the bit, byte, Dword, packet or command level.

The product provides a complete solution for test environments ranging from R&D to production.

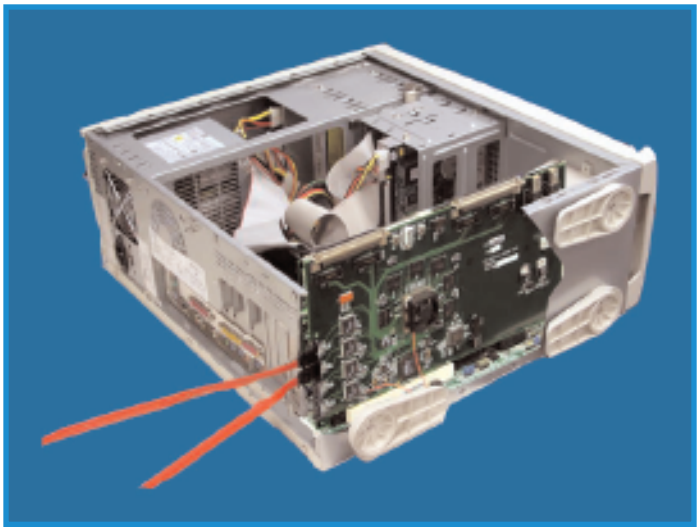


Figure 1: PM2 board inside a PC (cut away view)

PRODUCT DESCRIPTION

PM2 is a 64-bit PCI card that operates in a 32 or 64-bit socket in a Windows based PC (see Figure 1).

Depending on the card model, there is support for one, two or four SAS phy links.

Each link capable of emulating a host or device (see Figures 2 and 3 where two PM2 boards are detected by the software). PM2 supports line signalling rates of up to 3.0 Gb/s.

Two cards can be connected together via a sync cable to operate together to simulate up to 8 SAS links (on the four phy link versions of the PM2).

These links (see Figure 2) can also be configured to work together or separately for wide port operation. This function provides test engineers with the ability to have synchronized control over multi-lane traffic and simulate SAS components such as drives or host bus adapters.

There are four ways to interact with and control the PM2.

GUI WINDOWS APPLICATION

The first way is to use the GUI application; the other way is to use the API (Application Programming Interface).

The GUI application (see Figure 4) provides an easy to use interface to create and send SAS packet streams. It behaves like a word processor for packets with drag and drop, cut and paste, and insert and delete functions.

A series of simple pull-down menus provides all the options for inserting new packets into a new or existing stream for each link. One Packet Stream Editor will be opened for each link (in Link Mode).

The Multi-Link Editor (see Figure 5) makes it easy to work with more than one Stream Editor.

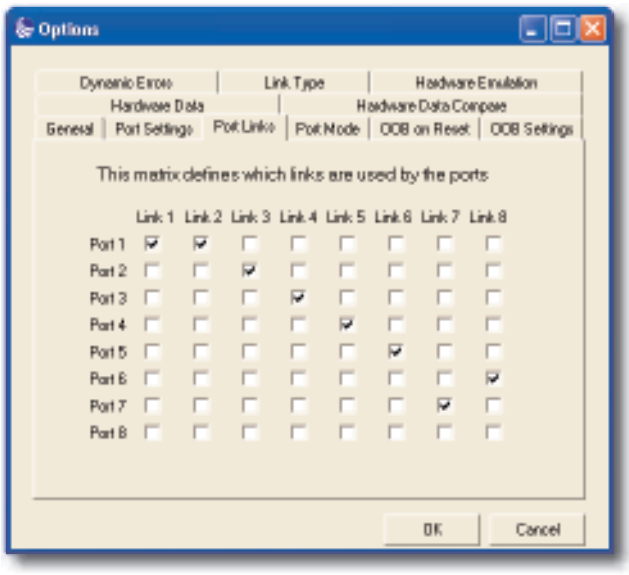


Figure 2: Configuring Links into Ports

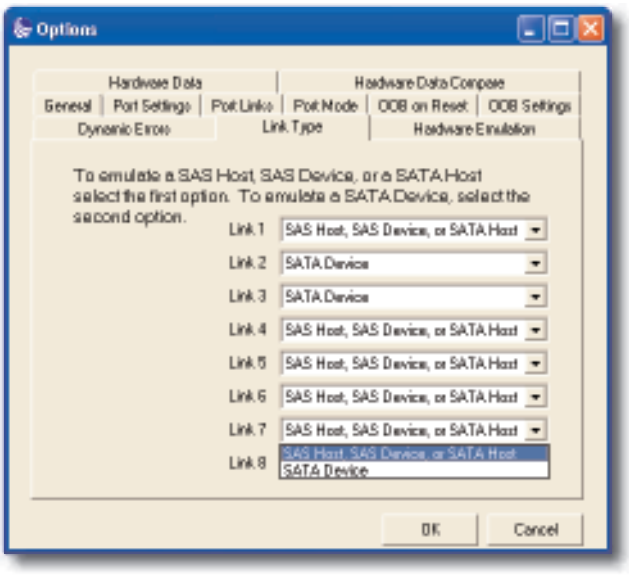


Figure 3: Link Type Setup

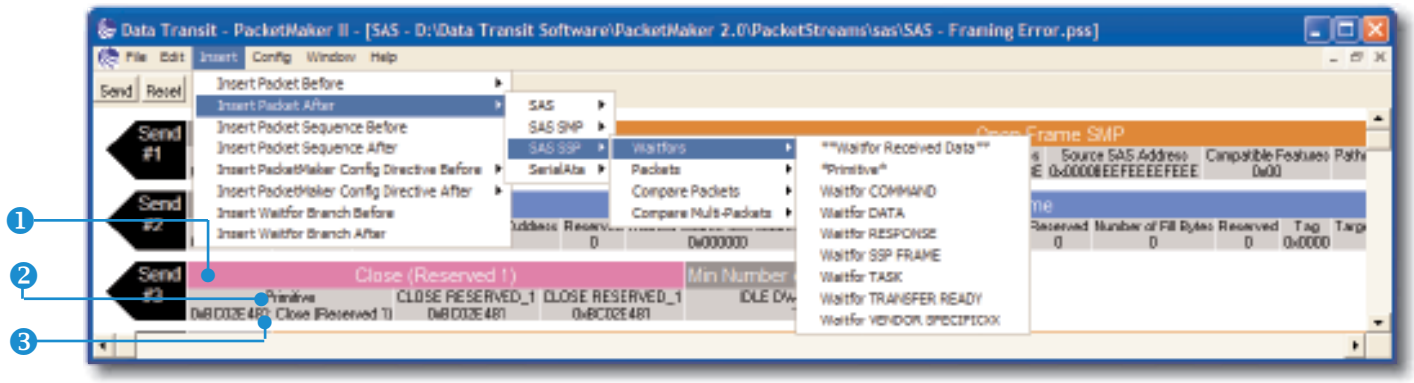


Figure 4: Creating a Packet Stream/Three Tier Structure

Packet Stream Objects are laid out horizontally with a three tier structure to help with quick recognition of the objects and easy understanding of their structure. The top tier ❶ describes the protocol structure, such as a command frame, Information Unit, or FIS type.

The second tier ❷ provides the field name. The last tier ❸ displays the field value. The colors for structures and fields are all user-definable, so the display can be changed to suit individual preferences. On the left of each object are colored indicators that clearly show whether the object will be sent, received or compared.

After inserting the packet, any of the default field values can be modified. Everything from changing how Align and Sync Primitives behave, to handshaking, credit management and flow control management is supported.

SAS Frames can also be altered to change parameters in fields, add additional fields or manipulate data fields with pre-programmed data patterns.

The GUI application allows for editing in three modes. In the legal mode, only valid structures and field values, as

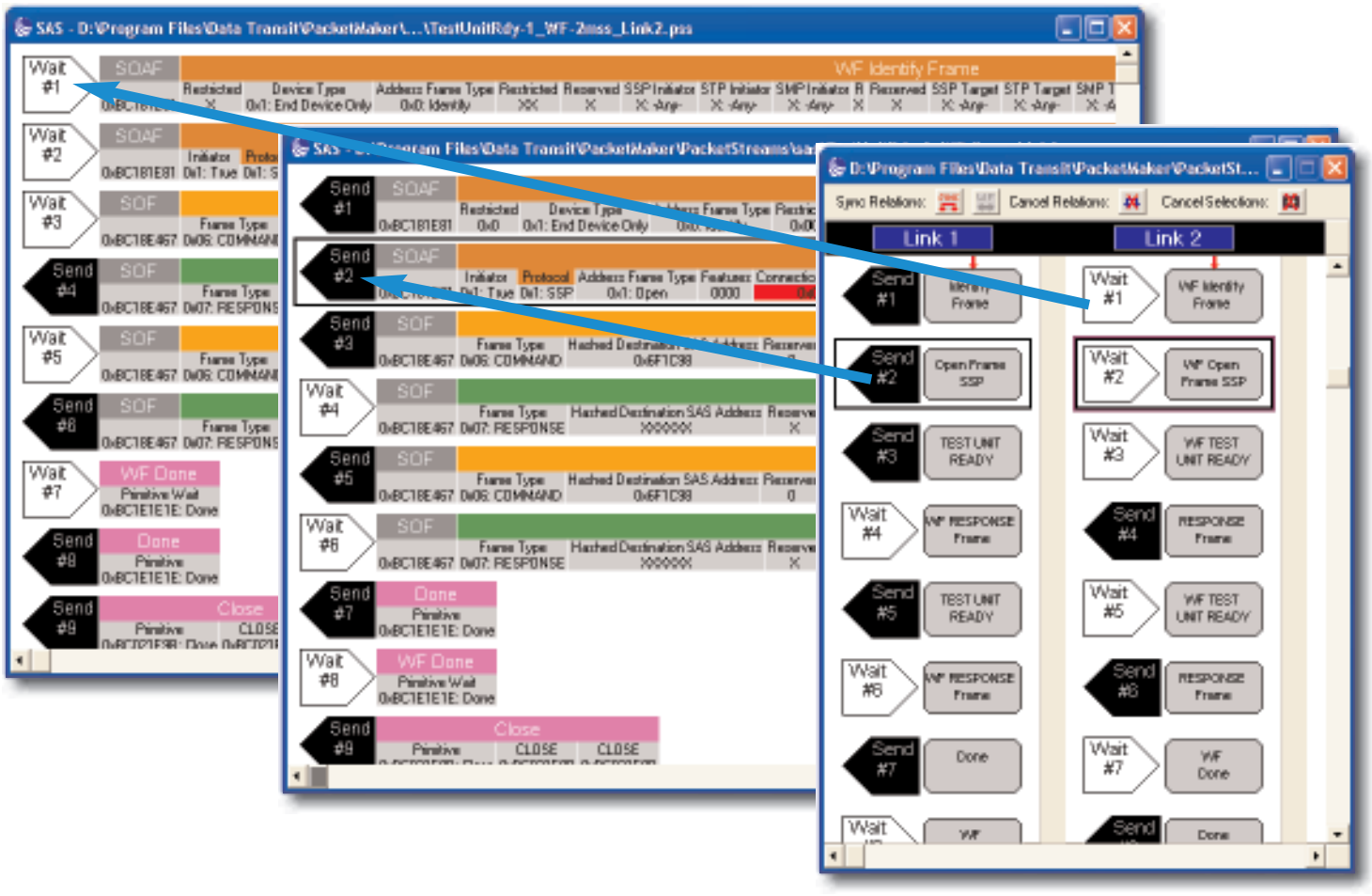


Figure 5: Extreme SCSI

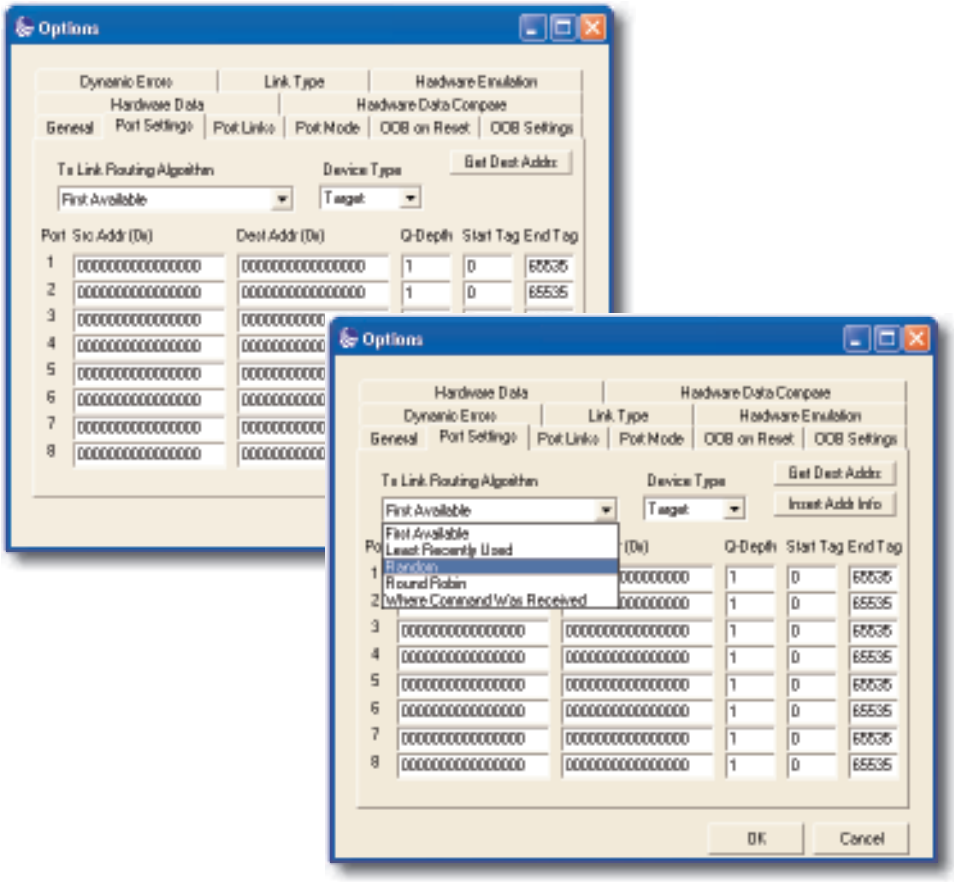


Figure 6: Link and Port Modes

defined by the Serial Attached SCSI protocol specifications, may be used.

In free form mode however, illegal structures, invalid field values, and other errors may be set up. Field values can be changed by simply double-clicking on them; Coding or Disparity Byte errors can be added. A pop-up menu provides the options for making the changes. By right-clicking on any field the user may delete it or insert another, with all the options made available through simple menus.

In the view only mode, the user can double-click on fields to bring up the editor, but will only be allowed to change display options such as colors. Insertion or deletion of packets is not allowed.

Once the Packet streams are created, they can be sent once, looped for a certain number of times, or looped infinitely. Predefined errors can be introduced into the SAS traffic at any time during the send process through software or a manual pushbutton.

There are other powerful features that are supported by the PM2 and can be utilized through the GUI. The PM2 supports Link and Port Mode (see Figure 6). In Link mode, users must insert the SAS addresses into the Link Mode scripts. However in Port mode, the target SAS addresses are automatically located allowing for auto-insertion of these addresses.

The PM2 also has the ability to vary the OOB (Out-of-Band signalling) timing; this unique feature allows the duration and frequency of COMINIT, COMSAS and COMWAKE to be easily adjusted to test initiator and target responses to such changes.

There is also another very unique feature: the hardware data generation and comparison. Data patterns are generated, transmitted and then checked. Errors are recorded and logged.

The PM2 also has analysis capabilities as it can monitor and record packet information and errors on the bus. If full SAS decode and analysis capabilities are required, the PM2 can be used with a Bus Doctor™ Serial Attached SCSI protocol analyzer.

C-BASED API

The second way to to create packet streams and to operate PM2 is with the C-based API. There are more than 400 function calls available in the API library. It supports all the functionality available in the GUI application but with more flexibility due to the power of the C programming language.

With the API, stand-alone programs can be written and re-run over and over again. PM2 comes bundled with a set of ready to use programs.

PACKETMAKER DEVELOPMENT SOFTWARE

The PM2 comes bundled with the PacketMaker Development Software package (Model Number: PM-DEV) (see Figure 7). This package provides three SAS/SATA focused test tools.

Extreme SCSI allows users to issue any SCSI command to any SAS/SATA device on any protocol. It provides unparalleled functionality in a tabbed interface for easy navigation and enhanced useability. Combine this with powerful utilities such (as Format, Microcode Download, Inquiry, Log and Mode Page sense and modification), media tools (copy, compare) and canned tests (Command Compliance, Reserved Bit Testing, Random Command sequencing). Operate on a single or multiple devices.

Extreme Manufacturing helps users test SAS/SATA peripheral. It provides a powerful yet simple test

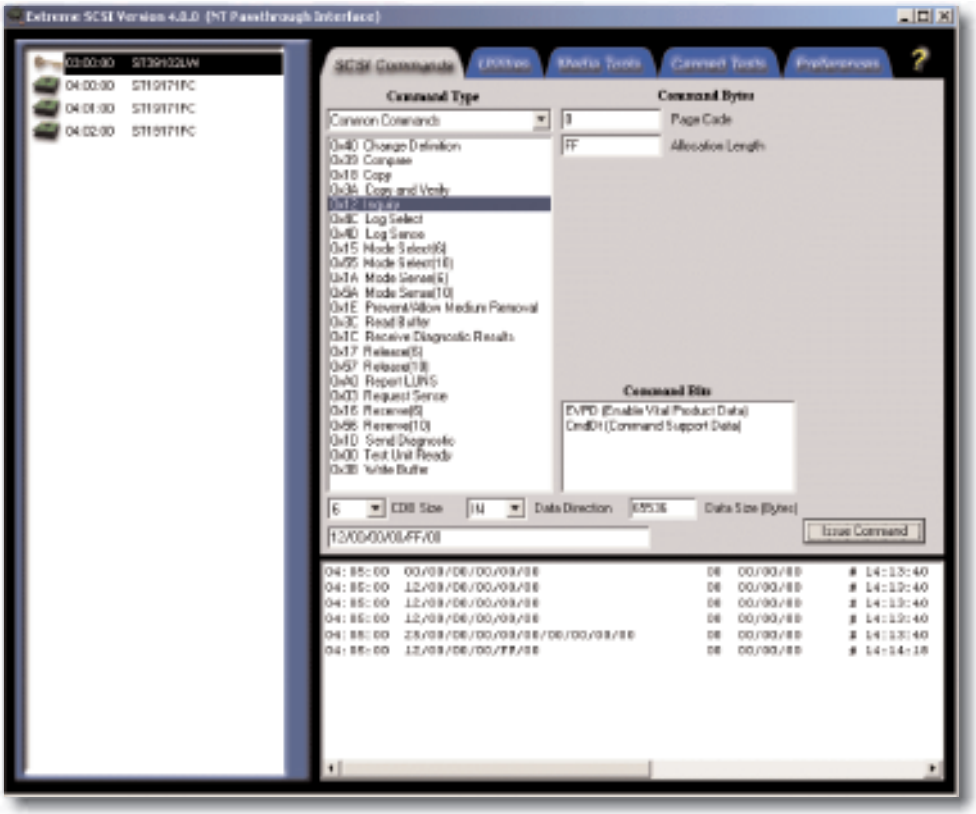


Figure 7: PacketMaker Development Software

environment driven by a scripting language. It can operate on any number of drives simultaneously, each running their own script. It offers customizable logging, device reports and system reports.

Scriptgen provides an easy to use interface that allows for complex test scripts to be created quickly. Choose from canned tests, insert individual SCSI commands, perform complex looping or conditional branching, launch executables, wait for user input before continuing, the list of features

PACKETMAKER SAS VALIDATION TOOLS (SVT)

In addition, an optional PacketMaker SAS Validation Tool (SVT) (Model Number: PM-SVT) is available (see Figure 8). This is a protocol verification tool designed for SAS targets and expanders.

The software test suite is a Windows application that operates with PM2. Consisting of several hundred tests drawn from the SAS specifications authored by the SCSI Trade Association, the SVT is capable of checking and validating many different areas of conformance to the SAS protocol specification.

There are tests for the Physical, Link, and Transport layers of SAS targets and expanders. Tests include aspects of:

Phy Layer
- OOB Burst Time
- OOB Idle Time
- OOB Sets
- Phy Reset

Link Layer
- BREAKs
- Credit compliance
- Connection tags
- Primitives
- Flow Control

The PacketMaker SVT employs a simple to use graphical user interface (see Figure 8) that allows the user to select which tests to run, to launch the tests and to display the results.

The tests are organized and grouped in the left window ❶ and are presented in a tree view format. A user selects the tests (or group of tests) to run by clicking on the checkboxes to the left of each test or test group heading.

Once the user has selected which tests to run, he or she can click the start button (triangle) on the menu bar to begin running the test sequence.

Special setup instructions for certain tests are displayed in the top right window ❷. The information instructs the user to take certain steps before the testing can proceed. For example, if the user sees the message: connect a target to link 1, the user must perform this action before the PacketMaker SVT continues running the rest of the tests.

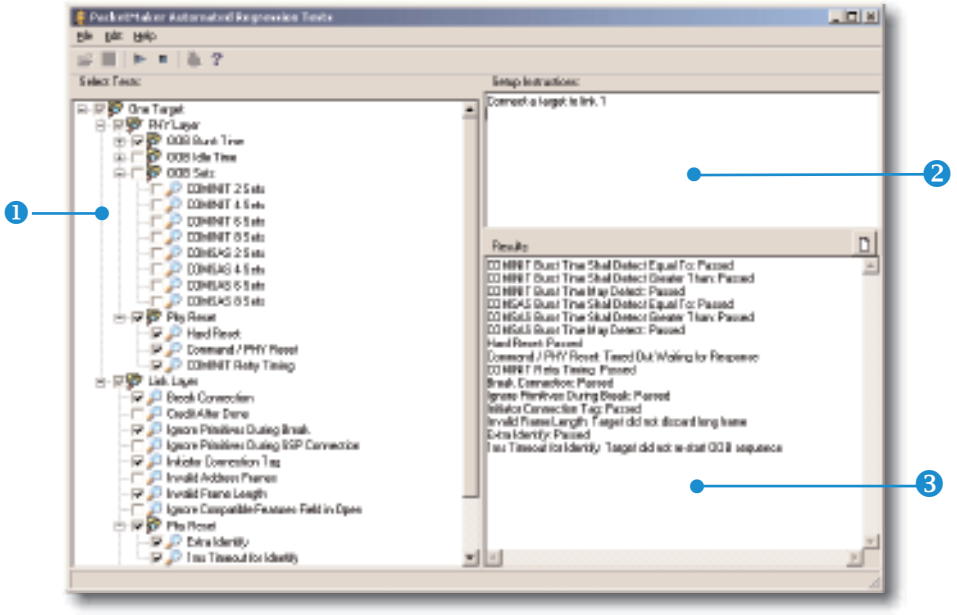


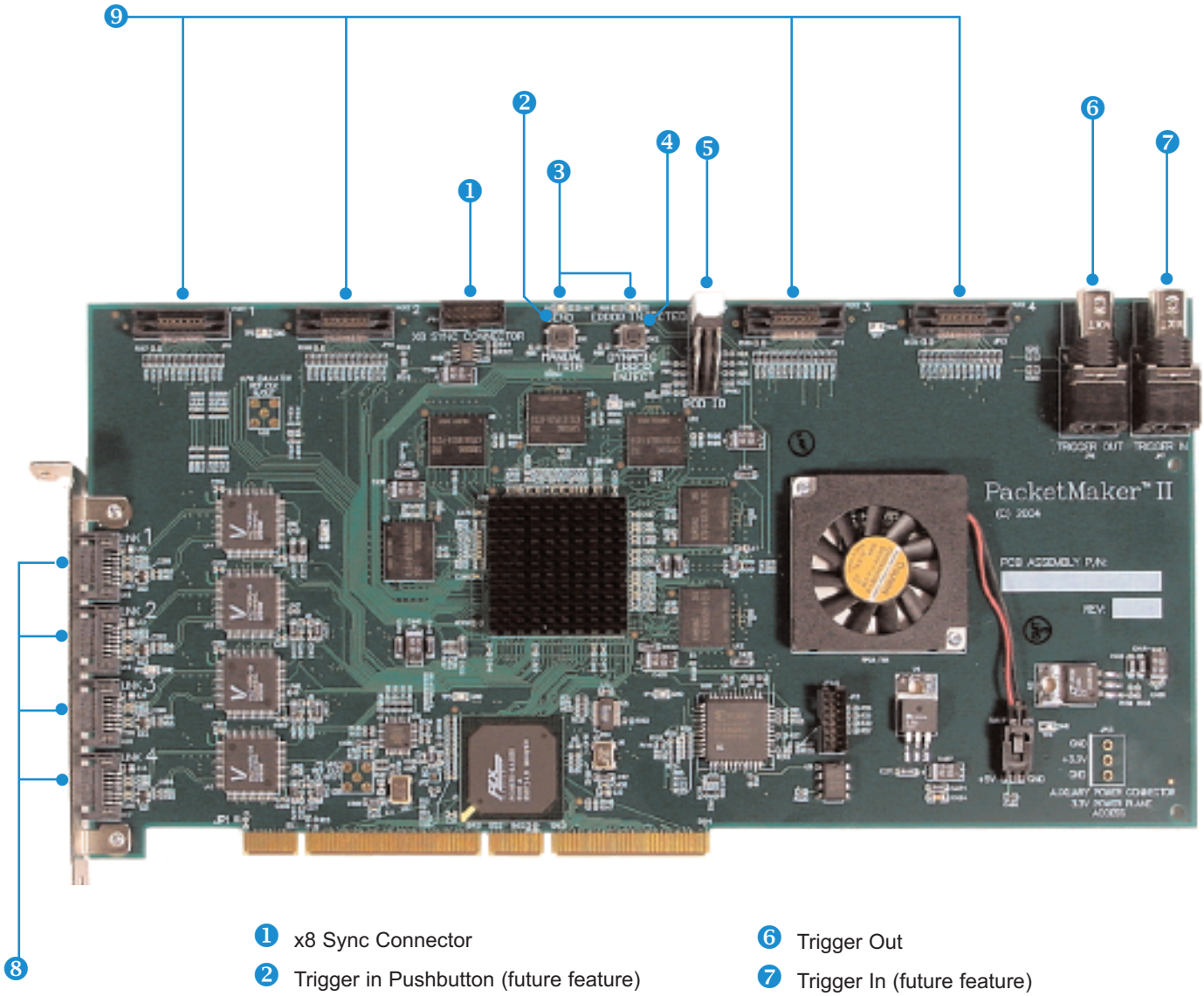
Figure 8: PacketMaker SVT's Main GUI Window

After each test is run, the results are shown in the window (❸ from previous page) on the bottom right hand side. Tests that passed are shown in green; tests that failed are highlighted in red with causes of the failure given. During the running of any particular test, the test name shows up in blue color in the “select test” window. The result window is a scrolling text display.

The information shown in the results windows is saved into a log file. In addition, this file can be printed.

Clear and concise help files describe the purpose of each test and the meaning of any specific output when a failure occurs.

PM2 provides hardware and software engineers with the power to test their new devices or controllers with virtually unlimited combinations of Serial Attached SCSI and Serial ATA protocol traffic. This capability dramatically reduces development and qualification time requirements.



1. x8 Sync Connector
2. Trigger in Pushbutton (future feature)
3. Status LEDs
4. Dynamic Error Pushbutton
5. Pod ID Display
6. Trigger Out
7. Trigger In (future feature)
8. SAS/SATA connectors
9. Mictor™ Connectors

APPLICATIONS

■ Design and Development Testing

To verify that a SAS drive is operating correctly, an actual host bus adapter (HBA) must be available (the converse is true as well); hard drive engineers can use PM2 to emulate a HBA to test out their drive designs. The emulated HBA can be programmed to send various packet streams to the SAS drive. Responses received back from the drive can be reviewed and evaluated (see Figure 9).

```
//The following code, written in C, illustrates building and sending a SSP packet stream. The code builds a command
frame with a Read(6) command in the CDB. The code loops 1024 times, incrementing the LBA in the CDB each iteration.

#include <stdio>
#include "saspm.h" //PacketMaker API Header file for SAS

int main( )
{
      unsigned long destAddress[2], long srcAddress[2];
      PacketID open[1]; //to hold PacketID's for Open frame
      PacketID read6[2]; //to hold PacketID's for Read(6)
      void* podIds;
      unsigned long maxPods, numPods, lbaID, size, i, j;

      //Initialize SAS PacketMaker Library
      InitSASPacketMaker("C:\\PacketMaker\\DLL\\","C:\\PacketMaker\\pm.cfg");

      //Create SSP Open Frame Packet Sequence
      destAddress[0] = 0x1734AC71; //Destination Address
      destAddress[1] = 0xB5973814;
            • • •
```

Figure 9: Sample Code Using the PM2 API

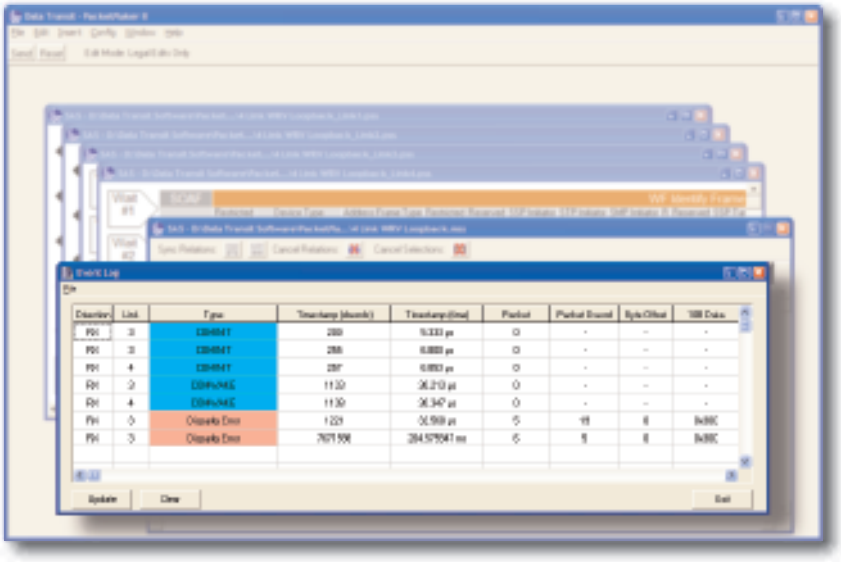


Figure 10: Event Log shows Special Events such as Errors and Packet Miscompares

■ Failure Analysis Troubleshooting

The PM2 records and saves all errors to a Event Log file. The information stored includes the type of error, link number, timestamp and other useful data. This important feature can help troubleshoot the cause of a SAS component failure or malfunction (see Figure 10).

■ Performance Analysis

Often it is necessary to check and verify whether a SAS component is operating in accordance to performance design during development. This can be checked by using PM2's Burst Mode or continuous looping on the same packet steam and observing and evaluating the effects on the SAS component. Latency values can be checked by reviewing the timestamp information in the Activity Log.

■ Protocol Verification

The PM2 allows for easy alteration of any of the fields in the packet stream, allowing different protocol test scenarios to be easily set up (see Figure 11). After the packet steam is transmitted, the effects on the SAS component can be examined and evaluated using the Activity and Event logs.

■ Manufacturing Tests

In a manufacturing test environment, there is a critical need to reduce and limit the amount of manual testing. The PM2's C-based API is an important tool in achieving test automation. It enables re-use of previously developed test programs so that they can be re-run over and over again with minimal user intervention.

Figure 11: Double-Click on any Field to Edit or Change It

FEATURES

FULL DUPLEX SAS PORTS (1.5 & 3.0 Gb/s)	Each card can generate and receive traffic on 1 to up to 4 SAS links (4 Phy Link versions of card).
CARD SYNCHRONIZATION	Two cards (4 Phy Link versions of card) can be synchronized to allow up to 8 links of traffic generation and reception.
PROTOCOL SUPPORT	Supports SSP, SMP, and STP (SATA) protocols.
SEQUENCE CONTROL PACKETS	Send packets, wait-for packets, branch packets, compare packets and more.
HOT-PLUG CONNECTIVITY	Simulates hot-plug events by forcing the Tx lines into common-mode voltage.
CONTROL / COMMAND REGISTERS	Allows user to create and modify behavior packets.
DATA STREAM CREATION	Enables easy payload generation using several data streams, including walking 1s, incrementing patterns, random patterns, and user files.
PROGRAMMABLE ERROR GENERATION	Capable of sending many types of bit and protocol errors. SAS Frames can also be altered to change parameters in fields, add additional fields or manipulate data fields with dynamic data.
DYNAMIC ERROR INJECTION	Allows user insertion of errors onto the SAS bus in real time. Errors such as CRC, 10b and disparity can be inserted at anytime in the packet stream.
EVENT LOGGING	Logs several key events, such as Errors Transmitted and Data Miscompares.
ACTIVITY LOG	Contains the information received and transmitted on the links.
WAIT STATES	User may set the amount of time to wait before sending the next packet. This can range from 26.67 ns to 8 hours.
BUILT-IN DIAGNOSTICS	Verifies device functionality using built-in diagnostics such as a Power On Self test or Out of Band (OOB) Signaling. There is also a memory initialization test to insure the memory on the PM2 is functioning properly.
PACKET DEVELOPMENT SOFTWARE	Simple to use GUI interface that easily allows creation and generation of packet streams as well as bus monitoring.
API TOOLKIT	Provides an API (Application Programming Interface) toolkit to generate packet streams and send traffic using C functions.
MICTOR CONNECTORS	Allows user to monitor the PHY transmit and receive 10b data paths.
LINK AND PORT MODE	Supports multi-link (Link Mode) and multi-port (Port Mode) packet streams. In Port Mode, commands are queued across multiple SAS links using one of five user selectable algorithms (i.e. round robin, random).
AUTO TARGET MODE	Useful when it is difficult or impossible to foresee and program in initiator activity sequence. Provide initiator with layered control
8B/10B HARDWARE ENCODING/DECODING	Performs time-sensitive 8b/10b encoding/decoding functions in the FPGA.
SAS OUT OF BAND FUNCTION	Can varying the timing and duration of SAS Out of Band (OOB) sequences to test device ability to handle them.

SPECIFICATIONS

FLOW CONTROL DIRECTIVES SUPPORTED	Send, Waitfor, Waitfor Branch, Compare, Multi-Compare, Config
FRAMES SUPPORTED	**ADDRESS FRAMES SUPPORTED:** AF 0 Identify, AF 1 Open **SSP:** IU 01 DATA, IU 05 XFER_RDY, IU 06 COMMAND, IU 07 RESPONSE, IU 16 TASK **SMP:** IU 40 SMP_REQUEST, IU 41 SMP_RESPONSE **STP:** FIS 27 Register – Host to Device, FIS 34 Register – Device to Host, FIS A1 Set Device Bits – Device to Host, FIS 39 DMA Activate – Device to Host, FIS 41 DMA Setup – Bi-directional, FIS 58 BIST Activate – Bi-directional, FIS 5F PIO Setup – Device to Host, FIS 46 Data – Bi-directional
OOB SIGNALS SUPPORTED	COMRESET / COMINIT, COMWAKE, COMSAS
PRIMITIVES SUPPORTED	**NON-CONNECTION SPECIFIC:** AIP NORMAL, AIP RESERVED 0, AIP RESERVED 1, AIP RESERVED 2, AIP RESERVED WAITING ON PARTIAL, AIP WAITING ON CONNECTION, AIP WAITING ON DEVICE, AIP WAITING ON PARTIAL, ALIGN 0, ALIGN 1, ALIGN 2, ALIGN 3, BREAK, BROADCAST CHANGE, BROADCAST RESERVED 0, BROADCAST RESERVED 1, BROADCAST RESERVED 2, BROADCAST RESERVED 3, BROADCAST RESERVED 4, BROADCAST RESERVED CHANGE 0, BROADCAST RESERVED CHANGE 1, CLOSE CLEAR AFFILIATION, CLOSE NORMAL, CLOSE RESERVED 0, CLOSE RESERVED 1, EOAF, ERROR, HARD_RESET, NOTIFY ENABLE SPINUP, NOTIFY RESERVED 0, NOTIFY RESERVED 1, NOTIFY RESERVED 2, OPEN_ACCEPT, OPEN_REJECT BAD DESTINATION, OPEN_REJECT CONNECTION RATE NOT SUPPORTED, OPEN_REJECT NO DESTINATION, OPEN_REJECT PATHWAY BLOCKED, OPEN_REJECT PROTOCOL NOT SUPPORTED, OPEN_REJECT RESERVED ABANDON 0, OPEN_REJECT RESERVED ABANDON 1, OPEN_REJECT RESERVED ABANDON 2, OPEN_REJECT RESERVED ABANDON 3, OPEN_REJECT RESERVED CONTINUE 0, OPEN_REJECT RESERVED CONTINUE 1, OPEN_REJECT RESERVED INITIALIZE 0, OPEN_REJECT RESERVED INITIALIZE 1, OPEN_REJECT RESERVED STOP 0, OPEN_REJECT RESERVED STOP 1, OPEN_REJECT RETRY, OPEN_REJECT STP RESOURCES BUSY, OPEN_REJECT WRONG DESTINATION, SOAF **SSP AND SMP:** ACK, CREDIT_BLOCKED, DONE ACK/NAK TIMEOUT, DONE CREDIT TIMEOUT, DONE NORMAL, DONE RESERVED 0, DONE RESERVED 1, DONE RESERVED TIMEOUT 0, DONE RESERVED TIMEOUT 1, EOF, NAK CRC ERROR, NAK RESERVED 0, NAK RESERVED 1, NAK RESERVED 2, RRDY NORMAL, RRDY RESERVED 0, RRDY RESERVED 1, SOF **STP:** SATA_CONT, SATA_DMAT, SATA_EOF, SATA_ERROR, SATA_HOLD, SATA_HOLDA, SATA_PMACK, SATA_PMNAK, SATA_PMREQ_P, SATA_PMREQ_S, SATA_R_ERR, SATA_R_IP, SATA_R_OK, SATA_R_RDY, SATA_SOF, SATA_SYNC, SATA_WTRM, SATA_X_RDY **USER-SPECIFIED**
BIT ERRORS SUPPORTED	10b Coding Error, 10b Disparity Error, Unknown Primitive, CRC Error
PROTOCOL ERRORS SUPPORTED	Framing Errors, Undersized Packets, Oversized Packets, Arbitration Failure and Retry **SSP:** Sending a NAK (CRC Error) primitive, not sending an ACK or NAK primitive, timeout errors **STP:** Sending SYNC primitives while receiving an STP packet, not sending HOLDA primitives when a HOLD primitive is received, simulating an error with a received STP packet by sending an R_ERR primitive, not sending an R_RDY primitive when an X_RDY primitive is received, sending an STP without first sending an X_RDY primitive **SMP:** Timeout Errors, unknown SMP Request, unknown SMP Response

HARDWARE SPECIFICATIONS (PM-SAS-1504Qe)

MECHANICAL

DIMENSIONS

Height: 5.7 inches (145 mm) (includes fingers)
Width: 11.4 inches (290 mm)
Weight: 0.65 lbs (295 grams)

CONNECTORS

64 bit 66 MHz PCI edge
4 Mictor connectors(1)
4 Standard SAS connectors(2)
BNC Trigger Out
BNC Trigger In (future feature)

POWER SPECIFICATIONS

PCI EDGE POWER REQUIREMENTS

3.3 V Supply:
Voltage . . . . . .3.3 V± 4%
Maximum Current (Iccmax) 6A
5V Supply:
Voltage . . . . . .5 V ± 10%
Maximum Current (Iccmax) 0.5A

DC SIGNALING

PCI SIGNALS

"3.3 V Card" found in the PCI 2.2 specification.

MICTOR CONNECTORS

LVCMOS 3.3V Per EIA/ JESD8-B standard

TRIGGER OUT

LVCMOS 3.3V Per EIA/ JESD8-B standard

AC TIMING

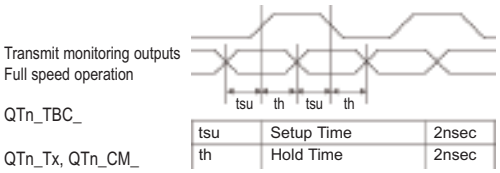
PCI SIGNALS

Per PCI 2.2 specifications

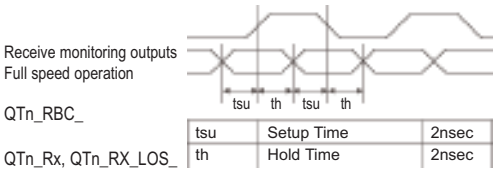
SAS CONNECTORS

Signaling Rate . . . . . .1.5 Gb/s
Clock Jitter . . . . . .< 100 ps

MICTOR CONNECTORS(3) (Represent the Mictor AC timing characteristics for this product for monitoring parallel 10b Tx and Rx data for each link)



tsu	Setup Time	2nsec
th	Hold Time	2nsec



tsu	Setup Time	2nsec
th	Hold Time	2nsec

ENVIRONMENTAL

Maximum Ambient Temperature: 50° C
Maximum Relative Humidity: 90%
Airflow: Per Intel® ATX specification

SUBSYSTEM

PCI SPECIFICATIONS

Width: Compatible with 32 or 64 bit wide PCI bus sockets and most PCI-X sockets
Speed: Compatible with 33 or 66 MHz bus speeds
Burst mode bandwidth:
Best case (66Mhz 64 bit PCI) . . . . . .~504 MBytes/s
Worst case (33Mhz 32 bit PCI) . . . . . .~126 MBytes/s
Transfer Modes: Uses Single Read/Write and DMA Read/Write PCI transfers

(1): 1 Mictor Connector on PM-SAS-1501e.

(2): PM-SAS-1504e and PM-SAS-1504Qe only. PM-SAS-3001e has 1 and PM-SAS-3002e has 2 SAS connectors.

(3): Recommended analyzer clock setup is for positive or negative clock skew from data of 2 ns.

SYSTEM REQUIREMENTS

- Windows® XP Professional or Windows 2000 Professional(A) operating system
- Intel® Pentium® IV 2.0 GHz or faster processor
- Minimum of 256 MB system RAM
- 50 MBytes of hard drive space for program files
- 32 or 64 bit PCI bus socket for insertion of PM2 board, operating at 33 or 66 MHz(B)
- PC case capable of accommodating a PCI board 5.7" inches in height

Caution: If PacketMaker II is used in an open case, then airflow devices to maintain proper system cooling are required.

(A): Operation of multiple cards under Windows 2000 is not recommended. Please use Windows XP Professional instead.

(B): Most PCI-X sockets are capable of 66 MHz operations.

PRODUCT ORDERING INFORMATION

Model Number	Description
	PacketMaker II Traffic Generators(1)
PM-SAS-1501e	SAS PacketMaker II, 1 Phy Link, (1.5 Gb/s)(2)
PM-SAS-1504e	SAS PacketMaker II, 4 Phy Link, (1.5 Gb/s)(2)
PM-SAS-1504Qe	SAS PacketMaker II, 4 Phy Link, H/W emulation, (1.5 Gb/s)(2)
PM-SAS-3001e	SAS PacketMaker II, 1 Phy Link, (1.5 & 3.0 Gb/s)(2)
PM-SAS-3002e	SAS PacketMaker II, 2 Phy Link, (1.5 & 3.0 Gb/s)(2)
	Software
PM-DEV	PacketMaker Development Software Upgrade(3)(4)
PM-SVT	PacketMaker II SAS Validation Tool(4)

Model Number	Description (SAS Analyzers/Related Products)
	USB-Controlled Analyzers
RX-108P-SLIM	Bus Doctor RX, 108 channels, 64M events buffer
RX-108P-FIT	Bus Doctor RX, 108 channels, 128M events buffer
RX-108P-BUFF	Bus Doctor RX, 108 channels, 256M events buffer
RX-252P-SLIM	Bus Doctor RX, 252 channels, 64M events buffer
RX-252P-FIT	Bus Doctor RX, 252 channels, 128M events buffer
RX-252P-BUFF	Bus Doctor RX, 252 channels, 256M events buffer
	Bus Pods
DR-SAS-3000	Serial Attached SCSI pod, (1.5 & 3.0 Gb/s)(5)
DR-SATA-3000	Serial ATA pod, (1.5 & 3.0 Gb/s)(5)
DR-SAS-3004	4x SAS Pod, SATA Connectors, (1.5 & 3.0 Gb/s)(6)
DR-SAS-30W4	Wide Port SAS Pod, MicroGiga Connectors (1.5 & 3.0 Gb/s)(6)

(1): Includes: PM2 board, GUI control software, user manual and API.

(2): Includes PM-DEV.

(3): Provides 3 SAS/SATA focused PacketMaker II test tools that cut the development process and time-to-market of new SAS/SATA devices.
- *a) Extreme SCSI issues any SCSI command to any device running the SAS/SATA protocols.*
- *b) Extreme Manufacturing test environment is designed for SAS/SATA peripheral testing as well as manufacturing, DVT, ORT, incoming inspection and final inspection.*
- *c) Scriptgen is an easy to use tool for rapidly creating simple or complex test scripts.*

(4): Requires a PacketMaker II Traffic Generator.

(5): Compatible with RX-108P Analyzers.

(6): Compatible with RX-252P Analyzers.

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